Journal of Scientometric Res. 2021; 10(2):184-194
http://www.jscires.org

Research Article

Science Research in Indian Universities: A Bibliometric Analysis

Sharad Kumar Sonkar[1], Sunil Kumar[2], Avijit Mahala[3], Manorama Tripathi[4,*]

[1]*Department of Library and Information Science, Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow, Uttar Pradesh, INDIA.*
[2]*Planning & Development Division, Indira Gandhi National Open University, New Delhi, INDIA.*
[3]*Kalindi College, University of Delhi (DU), New Delhi, INDIA.*
[4]*Dr B R Ambedkar Central Library, Jawaharlal Nehru University, New Delhi, INDIA.*

ABSTRACT
The paper highlights the research contributions of nine central universities of India, University of Delhi (DU); Aligarh Muslim University (AMU); University of Hyderabad (UoH); University of Allahabad (UoA); Jawaharlal Nehru University (JNU); Jamia Milia Islamia (JMI), University of Pondicherry (UoP), Babsaheb Bhimrao Ambedkar University(BBAU) and Banaras Hindu University (BHU), in the field of science in the ten years, 2011-2020, as reflected through SCI, EXPANDED, Web of Science. There were 53617 publications with 796,353 citations, 14.9 citations per publication. The Banaras Hindu University, Varanasi, contributed 23.4% of the total publications. RSC advances was the most popular journal among the researchers. The examination of research contributions of specific nations, institutions with the help of bibliometric tools and techniques should be done periodically; this study is valuable in understanding the research contributions of the nine central universities in India in the science discipline. The study helps in identifying core journals in which the researchers publish. It can also be relevant in formulating a framework based on an input-output research model for releasing grants to institutions; thus, this comparative study on research output is meaningful for fund granting bodies.

Keywords: Central universities, Citations, Research outburst, Research productivity, Publishing trends, Authorship pattern.

Correspondence
Manorama Tripathi
Dr. B R Ambedkar Central Library, JNU, New Delhi, 110067, INDIA.
Email id: manoramatripathi2@yahoo.com
ORCID ID: 0000-0002-7206-2855

Received: 27-08-2020
Revised: 03-02-2021
Accepted: 26-08-2021
DOI: 10.5530/jscires.10.2.33

INTRODUCTION

Universities worldwide exist to generate new knowledge through research endeavours of their departments and laboratories. The generation and dissemination of new knowledge lead to socio-economic development and high-performance indicators. The countries which want to evolve as knowledge economies should focus on creating, disseminating and preserving knowledge. The three components of sustainable development- environmental, economic and social are accelerated by the research activities of any country.[1] Universities are enablers of a global knowledge economy. They provide public and private goods (by imparting education and teaching and also address issues of climate change, food security, ageing population,[2] and pandemic, the latest one added to the list.

The universities engage in capacity building and are also gateways to global scientific information by providing opportunities for scientific communication.[3] The governments worldwide are also investing in developing universities as centres of excellence. Nations with brilliant research cultures and ecosystems are usually known to be in the club of developed nations. If India as a nation could become self-dependent in terms of food production the credit goes to the agricultural scientists of the nation who could with their research, conjure breakthroughs to increase the productivity manifold. During the corona pandemic, the researchers across the globe went into overdrive to speed up solutions. Those who could not only saved lives at home but also supported other nations fight the pandemic with their exports of medicines. Beyond doubt, research becomes the most favourable matrix for any solution. Research has a direct impact on the economy of a country.

Consider one of the recent examples, the IPCC report on Climate Change (IPCC, 2021). In its very opening para, the report mentions how many researchers across the globe had been working on the same thus substantiating the validity of the same. Research deep delves into the details, challenges and issues of a given ecosystem and then comes up with ways to better the space. If the implementation is the shoot of a plant, research happens to be the roots and the soil which anchors, fosters and nourishes it. The research community globally has been talking of translational research. It is research that translates into real impact whether that is a solution to a given problem or impact

Copyright
© The Author(s). 2021 This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

on the planet and people. As the global thought leaders press the panic button on climate change and the impending disasters that may follow, if we humans don't reign in our overindulgence and the excessive the exploitation of the planetary resources- we all again look up to the scientists and researchers to save the day.

The higher education system of India comprises 45 centrally funded, 318 state funded and 185 state private universities, 129 deemed universities, 51 institutions of national importance. Further, there are more than 37,000 colleges affiliated with universities in India (Government of India, 2021). The present paper highlights the research performance of nine central universities in the science field. The central universities are directly funded by central government, hence are better established and adequately funded than most of the state funded universities. The central universities set benchmarks and trends in research for other higher educational institutions in the country to follow. Most of these have been ranked high by National Institutional Ranking Framework (NIRF), Ministry of Education. The National Institutional Ranking Framework was launched in 2015 to caliber and rank academic excellence of higher education institutions in India (NIRF, 2019). In this study, researchers used purposive sample and selected nine central universities ranked high in NIRF to understand their research contributions by quantum and nature of research publications and authorship in the last ten years. This is an exploratory quantitative research study examining research performance in science discipline in the last decade of the nine central universities. The study highlights a cohort annual growth of research publications, authorship, and number of citations in each central university over a period of ten years. It identified the most popular journal of science discipline in each university preferred for publishing. These nine universities are University of Delhi (DU); Aligarh Muslim University (AMU); University of Hyderabad (UoH); University of Allahabad (UoA); Jawaharlal Nehru University(JNU); Jamia Milia Islamia (JMI), University of Pondicherry (UoP), Babsaheb Bhimrao Ambedkar University(BBAU) and Banaras Hindu University (BHU). Science Departments of these universities are well known for their quality research work.

Literature Review

Guskov *et al*.[4] have elaborated how, under the Russian Project 5, top 100 universities increased fivefold in the period 2010–2016. The study identified factors which were behind the increased research output - were Russian conferences whose proceedings were indexed in Scopus; the leading universities preferred to publish in international journals over local ones; two universities published in predatory journals as well. The study also reported that productivity per author grew insignificantly during the period, there was one article per author per year.

The Management Schools of Harvard, Wharton and University of South Carolina maintained high standards throughout the period of 40 years. During the recent years, China University of Hong Kong and University of Hong kong have emerged as important contributors in the discipline of Business and Management Studies (Aissaoui and Geringer, 2018). Cao[5,6] has highlighted that China ranks first in the number of researchers and second in the amount invested in R&D but lags behind in international patent applications and the market share of high-quality achievements. The author used data from OECD database and conducted a questionnaire survey to study the reasons. The study highlighted that there was lack of sound industry- university –research institutional collaboration, the conversion rate of science and Technology achievements was less and the institutional support was inadequate to promote scientific research.

Kivinen, Hedman and Kaipainen[7] have studied the research productivity of 300 universities of 4 north European and East Asian Countries in the fields of Natural Sciences, Technology and Clinical medicine by using a input-output relational model. The National University of Singapore was on the top in all the three fields. The study stated that North European countries were better on knowledge economy indicators whereas East Asian countries were better on indicators of learning outcomes and by productivity in Natural Sciences and Technology; North European countries were strong in Clinical Medicine. Jeon and Kim[8] highlighted the research output of Universities of South Korea, where performance-based funding programmes are followed; the study reported gaps in the research activities of the Universities. Aldieri *et al*.[9] have investigated the influence of internal and external research collaboration on the scientific performance of the 254 academic institutions of Germany, France, Italy, the UK and Russia; the study highlighted that research collaboration catalyses the knowledge transfer among researchers which enhances the quality of research.

Batcha (2018) analyzed articles published from 2000 to 2017 by the top six universities of Tamil Nadu and highlighted that the number of articles grew at 9.76% per annum and the average citation per paper was 12.18. The Indian researchers collaborated with researchers from the USA and South Korea. Pastor, Serrano and Zaera[10] compared the research output of European Union higher educational institutions during the period 1996- 2010 in terms of quantity and quality. The study showed that the UK, Germany, France, Italy and the Netherlands contributed the most, but their growth did not exceed 70% annually; other countries like Cyprus, Portugal, Romania, Lithuania, Ireland registered a growth of 14% per annum. Overall, the growth of the research output of higher

educational institutions of EU 6.5% was more significant than the world average of 5.9%.

Kumar and Kolle[11] studied the research output in Information science and Library science subject category of Web of Science, published during 1919 to 2015; a total of 708 published articles were analyzed; India's share was just 1.04%; the articles published in 1996- 2005 had great impact in terms of citations; multi authorship dominated the landscape. Satpathy and Kumar[12] compared the research output of state universities of Orissa, India by analysing 490 articles published during 2010-14 and indexed in Scopus. The study highlighted that Utkal University was the most productive university with a share of 37.76% of the total research publications. Physics and Astronomy was the most pursued subject fields in universities situated in Orissa. Multi authorship dominated the scholarly communication landscape with degree of collaboration of 0.97. The University College of Medical Sciences, UCMS published 2557 research articles during 1975-2013, indexed in Scopus. Most of these research papers were written in collaboration, degree of collaboration was 0.92 and USA was the most sought after country for research collaboration.[13]

METHOD OF STUDY

This study was based on secondary data; extracted from SCI, which is an integral component of WoS, an online bibliographic and citation indexing service maintained and published by Clarivate Analytics. The WoS core collection indexes 41 different types of documents include articles, proceedings, book reviews, reviews and poetry. In basic search web page on citation index portal of WoS, '2011–2020' was entered in 'year published' field and 'SCI in the 'setting' column to get data for the study. All records searched and indexed by SCI against this query were further refined by country (India). The authors applied filters of universities and got 53,617 records of nine central universities under study, which were analysed in this study. These records were downloaded in batches of 500 (a maximum of 500 records can be downloaded at one time from WoS) and saved as MS-Excel file.

Descriptive and inferential statistics techniques were used to quantify research output of 9 central universities in India in Science discipline on the following parameters: annual growth in research output in terms of number of publications; number of authors in individual papers; cited reference counts, core journals in Science discipline in which Indian researchers frequently published; nature of contribution and language of publications of Indian researchers in science. The cohort analysis of these parameters explained trends in research publications in Science disciplines in the last decade. The inferential statistical techniques were applied to test null hypotheses. The data for the study was collected in February 2021. IBM-SPSS and MS-Excel were used for descriptive and inferential analysis.

Objectives

- To compare research productivity of nine central universities in Science discipline in the last ten years, 2011-2020 in terms of volume and nature of research contributions.
- To explore the trends in authorship of published research
- To identify core journals in Science discipline in which Indian researchers published
- To find out prime languages in which researchers published and communicated.

Null hypotheses

The review of literature reflects that number of citations is influenced by number of authors, length of paper, length of titles, and numbers of usage.[14-17] This study applied inferential statistics to reconfirm these facts in Science discipline in Indian context. The data on bibliometrics is controlled on these parameters and name of university to understand impact of these parameters i.e. number of authors, length of paper, length of titles, and number of usage and Name of the university on number of citations received by published research output. The null hypotheses are stated as H1 to H4.

H2: There is no association in number of citations and length of titles when data is controlled by name of university.

H3: There is no association in number of citations and length of research papers when data is controlled by name of university.

H4: There is no association in number of citations and number of authors when data is controlled by name of university.

H5: There is no association in number of citations and number of downloads when data is controlled by name of university.

RESULTS AND DISCUSSION

Research productivity and growth

The table highlights research productivity of 9 central universities in Science discipline in respect of annual growth across India and the world in the discipline as indexed in Science Citation Index.

Table 1 and Figure 1 reflect comparison of research contributions of science scholars in 9 Indian universities with rest of other Indian science scholars and world in the last one decade. The research contributions of world, India and 9 central universities constantly improved during the last decade. The research contributions of 9 central universities with respect to other Indian science scholars noted consistent annual drop in share

Table 1: Annual growth in research productivity in science discipline at national and global levels the last decade.

Year of publications	Numbers of research publications in Science Discipline			India share in % of world	9 central universities share in % of India
	World	India	9 Central Universities		
2011	16,10,506	51,751	4275	3.2	8.3
2012	16,89,384	54,951	4019	3.3	7.3
2013	17,84,723	61,379	4992	3.4	8.1
2014	18,35,550	66,592	5206	3.6	7.8
2015	18,89,531	69,583	5190	3.7	7.5
2016	19,71,777	75,086	5449	3.8	7.3
2017	20,40,713	78,567	5253	3.8	6.7
2018	21,23,087	84,643	6110	4.0	7.2
2019	23,19,424	97,006	6354	4.2	6.6
2020	23,67,690	1,06,323	6768	4.5	6.4

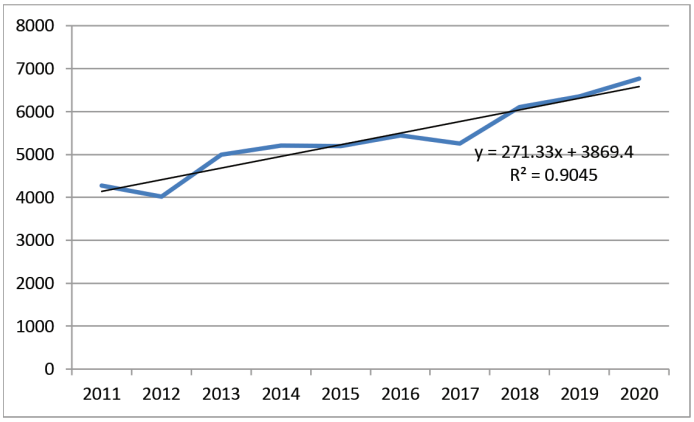

Figure 1: Annual growth of research publication in Science discipline by nine central Universities.

in the last decade with the highest share of central universities of 8.3% in 2011 and the lowest of 6.4% in 2020.

The trend line in Figure 1 reflects linear annual growth in research contributions of 9 central universities with average annual growth of around 271 research publications. The high value of correlation coefficient of linear trend validates consistent annual growth in research publications in Science Discipline. Table 1 reflects minor drop in number of publications in 2012 and 2017 by 9 central universities; there was a growing trend in the rest of years. Table 2 highlights research contributions of individual universities in science discipline in descending order.

The highest research contributions in science discipline in the last ten years was from BHU with 23.4% of total research publications; it was closely followed by University of Delhi with contribution of 23.0% of research publications hence top two central universities contributed about 46% of

Table 2: Research Productivity of nine Central Universities in science Discipline.

Name of Central University	No of Publications in 2011-2020	% share	Cumulative
Banaras Hindu University (BHU)	12534	23.4	23.4
University of Delhi (DU)	12324	23.0	46.4
Aligarh Muslim University (AMU)	6910	12.9	59.2
University of Hyderabad (UoH)	6177	11.5	70.8
Jawaharlal Nehru University (JNU)	4879	9.1	79.9
Jamia Millia Islamia (JMI)	4172	7.8	87.7
Pondicherry University (PU)	3196	6.0	93.6
University of Allahabad (UoA)	2348	4.4	98.0
Babasaheb Bhimrao Ambedkar University (BBA)	1077	2.0	100.0
Total	53617		

Cumulative research publications of nine Central Universities in the last ten years. The cumulative contribution of University of Allahabad and BBAU was just 7% of total research publications. Hence there are large gaps in research publications in science disciplines across the nine central universities in the last decade, which is further explained with cohort annual growth in published research work of each university in science discipline in Table 3.

Table 3 and Figure 2 reflect cohort annual growth in research publications of nine central universities. The annual growth in research publications of BBAU, AMU and University of Hyderabad was incoherent over the decade with sudden drops and rises in research publications. The rest of the universities had consistent annual growth in research publications in science discipline in the last decade. There was a trend of increasing research publications in the last five years in Jamia Milia Islamia.

The prime contributions of all the central universities were in the form of research papers; it is in the range of 92% from Pondichery to 84.4% from AMU (Table 4). The other major contributions were in the form of reviews of books; it was in the range of 10.6% for BBAU to 4.1% from university of Hyderabad. The third largest contribution was in the form of proceedings of meetings. JNU contributed remarkably in publishing of meeting abstracts; 5.0% of the publications were meeting abstracts reflect in Table 4.

Preferred destinations of publications

Table 5 shows International commercial publications in science discipline have wider publicity across the globe, it is reflected by high value of impact factor of international

Table 3: Annual Growth in research publication of 9 central universities in Science Discipline.

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
DU	Papers	1062	615	1205	1244	1219	1293	1346	1433	1392	1515	12324
	Annual growth		-42.1	96.1	3.2	-2.0	6.1	4.1	6.5	-2.8	8.8	
BHU	Papers	1149	1058	952	1446	1236	1211	1244	1341	1412	1486	12534
	Annual growth		-7.9	-10.1	51.9	-14.5	-2.0	2.7	7.8	5.3	5.2	
AMU	Papers	569	664	592	616	673	871	380	762	887	897	6910
	Annual growth		16.6	-10.9	4.1	9.2	29.4	-56.4	100.8	16.4	1.1	
Jamia	Papers	237	299	293	269	336	373	448	569	613	736	4172
	Annual growth		26.3	-2.0	-8.0	25.0	10.9	19.9	27.1	7.7	20.1	
JNU	Papers	275	338	316	419	469	511	540	660	656	696	4879
	Annual growth		23.0	-6.3	32.5	11.9	9.1	5.6	22.2	-0.6	6.1	
Hyderabad	Papers	447	529	1050	558	582	592	587	554	636	642	6177
	Annual growth		18.5	98.5	-46.8	4.3	1.7	-0.8	-5.7	14.7	0.9	
Pondicherry	Papers	199	183	253	307	351	292	394	420	409	387	3196
	Annual growth		-8.1	38.1	21.2	14.5	-17.0	35.1	6.7	-2.7	-5.4	
Allahabad	Papers	293	245	262	259	245	217	214	201	202	211	2348
	Annual growth		-16.5	7.1	-1.2	-5.5	-11.3	-1.4	-6.2	0.5	4.5	
BBAU	Papers	45	89	70	89	79	88	101	170	147	198	1077
	Annual growth		97.7	-21.8	27.9	-11.5	11.7	15.1	67.7	-13.3	34.3	
Total		4275	4019	4992	5206	5190	5449	5253	6110	6354	6768	53617
Annual growth			-6.0	24.2	4.3	-0.3	5.0	-3.6	16.3	4.0	6.5	

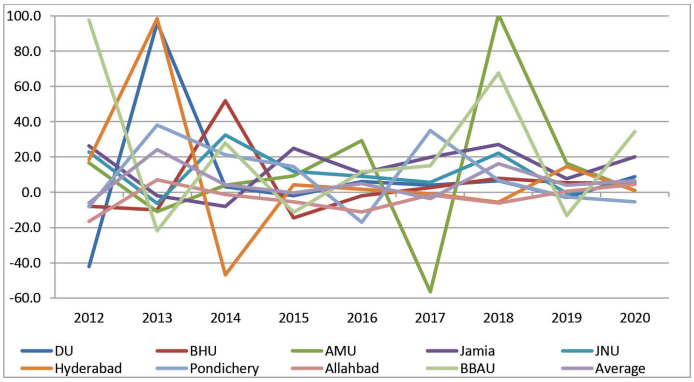

Figure 2: Annual Growth in research publication of 9 central universities in Science Discipline

journals. Research papers published in international journals have wider readership hence authors have better chances of getting visibility and citations for their research papers. 92.8% of research publications of the nine central universities in science discipline in the last decade were published by overseas publishers highlighted in the Table 5. 13.4% of publications of University of Allahabad were with inland publishers; while 3.6% of publications of Jamia were published inland. There are remarkable gaps in place (city/county) of publishing by Indian scholars; The popular cross border cities for publication of research in science discipline are Amsterdam with 6443 publications out of 49 thousand publications in the last decade. It was followed by New York with 5058 publications; Oxford with 4716 publications. Other cities with over one thousand publications were Cambridge, London, Washington, Abingdon, Philadelphia, Heidelberg, Bristol Hoboken, Lausanne and Dordrecht. In India, popular destinations for publishing research work in science discipline are New Delhi with 1435 research papers out of 3880 published in India. It is followed by publication houses located in Bangalore, Mumbai, Jodhpur, Allahabad with 977, 654, 185 and 149 publications in the last one decade. Rest of Indian cities have less than 100 publications in the last decade.

The publishers –Elsevier, Springer, and Wiley published the most number of articles of researchers from the nine universities. The main publishers are listed in Table 6.

Number of citations received by Indian researchers

The scientific endeavours generate new results which are disseminated through journal articles and book chapters. High number of citations to individual research paper reflects that specific research publications have been frequently accessed, read and built upon, thus these research publications played significant role in knowledge transfer among the researchers within a field and across the various fields. Numbers of Citations ultimately create impact factors of journals.

The majority of the scholarly articles in science discipline published by Indian scholars had low citations; but a few of them were highly cited. There are various factors like quality

Table 4: Different type of documents.

Name of university	Para meters	Research paper	Review	Meeting Abstract	Proceeding papers	Editorial Material	Corre ction	Letters	Book Chapter	Bio graphy	Retr action	News Item	Total
AMU	Papers	6175	355	96	100	73	49	50	2	3	5	2	6910
	%	89.4	5.1	1.4	1.4	1.1	0.7	0.7	0.03	0.04	0.1	0.0	
JNU	Papers	4116	289	243	72	89	30	25	6	4	2	3	4879
	%	84.4	5.9	5.0	1.5	1.8	0.6	0.5	0.1	0.1	0.0	0.1	
Jamia	Papers	3655	338	91	35	16	14	18	1	1	3	0	4172
	%	87.6	8.1	2.2	0.8	0.4	0.3	0.4	0.02	0.02	0.1	0.0	
Hyderabad	Papers	5541	251	119	108	76	33	36	4	7	0	2	6177
	%	89.7	4.1	1.9	1.7	1.2	0.5	0.6	0.1	0.1	0.0	0.0	
DU	Papers	10606	676	400	249	181	71	117	0	8	9	7	12324
	%	86.1	5.5	3.2	2.0	1.5	0.6	0.9	0	0.1	0.1	0.1	
BHU	Papers	10772	728	440	164	186	72	139	4	12	9	8	12534
	%	85.9	5.8	3.5	1.3	1.5	0.6	1.1	0.03	0.1	0.1	0.1	
Pondicherry	Papers	2939	121	29	33	19	21	31	2	0	1	0	3196
	%	92.0	3.8	0.9	1.0	0.6	0.7	1.0	0.1	0.0	0.0	0.0	
BBAU	Papers	912	114	20	6	13	6	4	0	0	2	0	1077
	%	84.7	10.6	1.9	0.6	1.2	0.6	0.4	0.0	0.0	0.2	0.0	
Allahabad	Papers	2110	132	45	18	28	14	0	0	0	1	0	2348
	%	89.9	5.6	1.9	0.8	1.2	0.6	0.0	0.0	0.0	0.0	0.0	
Total	**Papers**	**46826**	**3004**	**1483**	**785**	**681**	**310**	**420**	**19**	**35**	**32**	**22**	**53617**
	%	**87.3**	**5.6**	**2.8**	**1.5**	**1.3**	**0.6**	**0.8**	**0.04**	**0.1**	**0.1**	**0.0**	

Table 5: Preferred Destinations for publications.

Name of university	Overseas Publishers		Inland publisher		Total
	No	%	No	%	
Allahabad	2033	86.6	315	13.4	2348
BHU	11135	88.8	1399	11.2	12534
Pondicherry	2935	91.8	261	8.2	3196
BBAU	998	92.7	79	7.3	1077
DU	11541	93.6	783	6.4	12324
AMU	6541	94.7	369	5.3	6910
Hyderabad	5872	95.1	305	4.9	6177
JNU	4659	95.5	220	4.5	4879
Jamia	4023	96.4	149	3.6	4172
Total	49737	92.8	3880	7.2	53617

Table 6: Publishers in Science Discipline in last decade from 9 Central Universities.

Publishers name	Papers
Elsevier	13882
Springer	8737
Wiley	4657
Taylor and Francis	3033
Royal SOC Chemistry	2578
Amer Chemical SOC	1547
Amer Physical SOC	1425
Iop Publishing Ltd	1154
Academic Press INC Elsevier Science	1152
Indian Acad Sciences	967
Nature Publishing Group	740
Public Library Science	730
Amer Inst Physics	618
Bentham Science Publ Ltd	574
FRONTIERS MEDIA SA	513
Oxford Univ Press	511
National Institute of Science Communication and Information Resources-(CSIR-NISCAIR)	505

of contents of paper, journal impact factor, and number of authors, visibility in terms of usage, national and international collaboration which determine the number of citations.[14] The experts have shown that the articles with longer titles are downloaded slightly less than the articles with shorter titles.[15,16,17] The titles with colon receive a smaller number of downloads and citations. Obviously, the number of downloads and citations are linked with special characters in title such as colon /comma/semi column etc. Fox *et al.*[18] have elaborated that the length of the articles, and number of references have an impact the number of citations. Long papers are considered positively and attract more citations. It

Table 7: Numbers of Citations Received.

S. No.	Numbers of citation received	No of papers	%
1	No citations	8909	16.4
2	1 to 5	17176	31.7
3	6 to 10	9034	16.7
4	11 to 20	8815	16.3
5	21 to 40	5834	10.8
6	41 to 100	3004	5.5
7	101 to 200	590	1.1
8	above 200	255	1.6
Total		53617	

may be because the long papers have more and diverse ideas which may attract wider readership and eventually more citations. It has been observed in science that multi authorship is on the rise. Further, hyper authorship has been underlined. Adams[19] analysed 15.7 million articles in journals indexed in Web of science over the period 2009–2018 and noted that large number of articles with over 1000 authors. A published research paper in physics discipline had 5154 authors. Castelvecchi.[20] Noted that number of authors in a publication has an impact on the number of citations received by it.

Table 7 summarizes number of citations received by research publications of nine central universities during 2011–2020 which are also indexed in WoS. Nine central universities contributed 53617 research publications in the last 10 years which received 796353 citations in total; thus, there was on an average 14.9 citations per article. The highest number of publications 17,176, received 1 to 5 citations. Whereas 8909 publications (16.4% of total publications) did not receive any citation. There were 4880 publications which received only one citation. 255 research papers individually received more than 200 citations out of which 24 had more than 1000 citations. The highest number of citations for a single paper was 6054.

Language of publications

Table 9 shows all the universities in the period of investigation published in English. There were only four publications in non-English represented in Table 9. The articles published in English get broad readership.[21] English is the international language in higher education and research; therefore researchers prefer to publish in English in order to gain visibility and citations. The articles published in English attract more citations than the ones published in regional languages, as readership of such papers is confined to local region. The universities should take note of this and impart training in research reporting and publishing in English.

Understanding citation trends

One of the prime aims of citation analysis is to explain quality of research publications in terms of number of citations received hence trend in citations have been widely covered in research publications to assess quality of research publication of individual journals, institutions, scholar, School/department, subject area or nation. The review of literature explained number of citations in terms of number of authors, length of title,[15,16] usage in short duration as well as in long duration. This study examined association of numbers of citations with numbers of authors, length of title, usage in 180 days and usage since 2013. Data is controlled by university publishing the papers.

The values of correlation coefficient of number of citations with average length (number of pages) of the publications, numbers of authors, usages in 180 days and usages since 2013 were significant for most of the universities. Statically it proves that length of paper, number of authors, and usages have positive impact on numbers of citations. The very low values of Pearson Correlation between number of citations with number of authors and length of title reflect poor association of these parameters with number of citations. There are remarkable gaps in values of correlation coefficient in number of authors and number of citations when data is controlled by name of university. The value of correlation coefficient in number of authors and number of citations is the lowest for BBAU (-.05) and it is the highest for JNU with .52. The large gaps in correlation coefficient reflect that association in number of citations with number of authors is not uniform across the universities.

The high values of Pearson Correlation between number of citations with usage in the last 180 days (short) and since 2013 (long) reflect strong association between these parameters. Research papers which are frequently used are also likely to be cited more. There were remarkable gaps in values of correlation coefficient of number of citations with number of usage in the last 180 days and with usages since 2013 when data is controlled by name of university. The value of correlation coefficient in usage in the last 180 days and number of citations was the lowest for AMU (.14) and the highest for University of Allahabad (.70).; similarly there are wide gaps in values of correlation coefficient in usage since 2013 with number of citations when data is controlled by name of university. The value of correlation coefficient in usage since 2013 with number of citations was the lowest for Allahabad (.47) and the highest for JNU (.87). The table reflects that association in number of citations with usage in the last 180 days and with usage since 2013 is almost alike so both parameters (usage in the last 180 days and usage since 2013) have similar impact on number of citations. The values of correlation coefficients in number of citations with number of usage since 2013 were higher than values of correlation coefficients in number of citations with number of usage in the last 180 days, hence number of citations can be better explained in terms of longer usage of publications. The number of usage since 2013 was

Table 8: Descriptive statistics of parameters of bibliometrics of nine central universities.

university	Parameter	Average no of authors	Average length of title in words	Avg times cited	Avg usage count in 180 days	Since 2013 Usage Count	Average no of page count
AMU	Mean	54.4	14.3	14.8	1.3	17.0	11.3
	Median	4.0	14.0	6.0	0.0	8.0	10.0
	Std. Deviation	216.6	4.9	30.1	4.6	30.9	7.0
JNU	Mean	9.9	14.0	15.2	1.9	19.9	11.7
	Median	4.0	14.0	5.0	0.0	8.0	11.0
	Std. Deviation	78.4	4.7	79.8	9.2	100.9	8.0
Jamia	Mean	4.9	13.7	14.2	1.8	18.8	11.0
	Median	4.0	13.0	6.0	0.0	9.0	10.0
	Std. Deviation	3.9	4.6	38.0	4.9	38.4	6.8
Hyderabad	Mean	75.1	13.7	14.1	1.5	22.3	10.4
	Median	4.0	13.0	7.0	0.0	13.0	9.0
	Std. Deviation	389.6	5.0	28.8	4.1	36.9	7.5
DU	Mean	183.8	14.1	16.6	1.4	21.7	12.4
	Median	4.0	14.0	6.0	0.0	10.0	10.0
	Std. Deviation	597.8	5.1	80.3	4.5	42.7	11.8
BHU	Mean	12.2	14.5	14.3	1.4	20.3	10.4
	Median	4.0	14.0	6.0	0.0	10.0	9.0
	Std. Deviation	69.1	5.0	52.5	4.5	37.6	9.0
Pondicherry	Mean	5.2	14.5	12.8	2.0	23.0	11.4
	Median	4.0	14.0	6.0	0.0	12.0	10.0
	Std. Deviation	15.6	4.8	24.6	7.5	46.4	20.6
BBAU	Mean	5.0	15.0	15.0	2.1	23.5	10.9
	Median	4.0	14.0	6.0	0.0	11.0	10.0
	Std. Deviation	3.8	4.8	30.7	4.8	37.9	6.2
Allahabad	Mean	4.2	13.8	13.6	1.1	18.3	9.5
	Median	4.0	13.0	5.0	0.0	10.0	8.0
	Std. Deviation	2.7	4.6	39.6	3.0	37.8	5.3

Table 9: Language wise distribution of papers published by selected universities.

Language	No of publications
French	1
Portuguese	1
Spanish	2
English	53613
Total	53617

more reliable parameter to usage in the last 180 days in explaining number of citations.

There are remarkable gaps in values of correlation coefficient of number of citations with numbers of words in titles when data is controlled by name of university. The value of correlation coefficient in Number of words in title and number of citations is the lowest for Pondichery (-.07) and the highest for University of Delhi, .06. Very low value of correlation coefficient between number of words in title and number of citation reflects that there was almost nil association between both the parameters.

Summary of inferential tests

Null hypothesis: There is no association in number of authors and number of citations.

The hypothesis is statistically rejected for University of Allahabad; Aligarh Muslim University; University of Delhi; BHU, Pondichery, Central University of Hyderabad; Jawaharlal Nehru University and University of Pondicherry. Low value of correlation coefficient (near to zero) between of numbers of citations and numbers of authors reflect poor association between the parameters.

Table 10: Association in Bibliometric Parameters with number of citations.

Name of University			Number of Authors	Llength of Title	Usage in the last 180 days	Usage since 2013
AMU	Number of citations	Pearson Correlation	.220**	.018	.136**	.608**
		Sig. (2-tailed)	.000	.129	.000	0.000
		N	6910	6910	6910	6910
JNU	Number of citations	Pearson Correlation	.516**	.046**	.701**	.873**
		Sig. (2-tailed)	0.000	.001	0.000	0.000
		N	4879	4879	4879	4879
Jamia	Number of citations	Pearson Correlation	.021	-.044**	.294**	.664**
		Sig. (2-tailed)	.170	.004	.000	0.000
		N	4172	4172	4172	4172
Hyderabad	Number of citations	Pearson Correlation	.057**	-.036**	.201**	.603**
		Sig. (2-tailed)	.000	.005	.000	0.000
		N	6177	6177	6177	6177
DU	Number of citations	Pearson Correlation	.132**	.059**	.356**	.672**
		Sig. (2-tailed)	.000	.000	0.000	0.000
		N	12324	12324	12324	12324
BHU	Number of citations	Pearson Correlation	.271**	.048**	.404**	.558**
		Sig. (2-tailed)	.000	.000	0.000	0.000
		N	12534	12534	12534	12534
Pondicherry	Number of citations	Pearson Correlation	.209**	-.072**	.248**	.682**
		Sig. (2-tailed)	.000	.000	.000	0.000
		N	3196	3196	3196	3196
BBAU	Number of citations	Pearson Correlation	-.054	-.043	.165**	.647**
		Sig. (2-tailed)	.075	.162	.000	.000
		N	1077	1077	1077	1077
Allahabad	Number of citations	Pearson Correlation	.170**	-.025	.330**	.473**
		Sig. (2-tailed)	.000	.218	.000	.000
		N	2348	2348	2348	2348

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Null hypothesis: There is no association in number of words in title and number of citations.

The hypothesis is statistically rejected for JNU, Jamia, Hyderabad, DU, BHU, and Pondicherry. Low value of correlation coefficient (near to zero) between numbers of citations and numbers of words in titles reflect poor association between the parameters

Null hypothesis: expressing no association in number of usage in the last 180 days and number of citations

It was rejected for all the central universities; high positive value of correlation coefficient between number of citations and usages in the last 180 days reflects that number of citations improved significantly with increase in usage in the last 180 days.

Null hypothesis expressing no association in number of usage since 2013 and number of citations

It was rejected for all the central universities. High positive value of correlation coefficient reflects that number of citation improved with increase in usage since 2013.

Name of the university was treated as controlled parameter while examining association between number of citations with number of authors, number of words in titles, length of paper, no of usage in the last 180 days and usage since 2013. In case name of university has no impact on number of citations than values of correlation coefficients of number of

citations with aforesaid parameters will be almost alike across all the universities. Large gaps in correlation coefficients in the Table 6 reflect that name of university (affiliation of authors) has impact on number of citations. The Table 5 also reflects remarkable gaps in mean and Standard Deviation of number of citations per publication across the nine central universities, hence name of university also influences number of citations and popularity of research publications.

Multi-authors trend across the universities

Table 8 indicates there are on an average 4.2 authors per research paper for University of Allahabad; while there are 75.1 authors per research papers for University of Hyderabad. There is remarkable gap in authorship trend across the nine central universities. The difference in authorship trend across nine central universities was statistically examined with the help of ANOVA test.

The Table 11 shows the value of Levene statistics highlighted unequal variances in numbers of authors in individual research papers across nine central universities (Table 11).

The Table 12 highlights the level of significance of the ANOVA test reflects remarkable gap in authorship trends across the nine central universities (Table 12). Dunnett C Post hoc test applicable for unequal variance is applied to identify universities having remarkable gaps in multi authorship.

The Null hypothesis states that there was no change in multi authorship trend across all nine universities, which was rejected hence there were remarkable gaps in authorship pattern across the universities. The Post-hoc test identified pairs of universities which had no significant difference in multi authorship pattern were Pondicherry-BBAU; Pondicherry-Jamia; BHU-JNU; and BBAU-Jamia.

Journals in which the researchers frequently published

The analysis highlighted that most of research publications of Indian scholars in science discipline were published in few selected journals, whereas a large number of journals had published less than 10 papers in the last decade shows in Table 13. For example, 10 journals which frequently published research work of AMU had published 965 articles out of 6910 papers in the decade; there were 696 journals –each just published one paper of AMU in the last one decade. Similarly 10 popular journals in JNU published 14.1% of total research work in the last one decade, there were 686 journals -each just published one paper from JNU during the period (Table 13).

The Table 10 lists states titles of top two journals in science discipline having highest number of publications from nine central universities. Their impact factors range from 2.3to 4.8,

Table 11: Test of Homogeneity of Variances for numbers of authors.

Levene Statistic	df1	df2	Sig.
1343.9	8	53608	0.000

Table 12: Results of ANOVA test.

Sum of Squares		df	Mean Square	F
Between Groups	263783593.0	8	32972949.1	307.119
Within Groups	5755461493.0	53608	107362.0	
Total	6019245086.0	53616		

Table 13: Preferences of Indian scholars for frequently publishing their research.

University	Unique journals	No of Publications	No of journals published 10 or more papers
AMU	1561	6910	155
BBAU	513	1077	15
BHU	2514	12534	293
JMI	1316	4172	65
JNU	1394	4879	85
PU	1016	3196	63
UoA	789	2348	37
UoD	2430	12324	256
UoH	1419	6177	134

Table 14: Popular journals for publishing work across all the university.

Name of University	Journals	No of publications	Impact Factor
AMU	International Journal of Biological Macromolecules	178	4.78
	RSC Advances	138	3.05
JNU	Scientific Reports	146	4.01
	Plos One	128	2.74
JMI	International Journal of Biological Macromolecules	105	4.78
	Phys Rev D	79	4.83
UoH	RSC Advances	102	3.05
	Scientific Reports	100	4.01
DU	J High Energy Phys	345	5.875
	Phys Lett B	255	4.384
BHU	RSC Advances	276	3.05
	Curr Sci India	138	
PU	RSC Advances	77	3.05
	Indian J Geo-Mar Sci	55	
BBAU	Ecol Eng	22	3.512
	3 Biotech	20	1.798
UoA	J Indian Chem Soc	85	
	Tetrahedron Letters	65	2.26

thus researchers preferred to publish in journals having high impact factor.

The Table 14 reflects that RSC Advances was a popular journal, frequently published research articles of nine universities. This journal was the most popular journal in 4 central universities i.e. AMU, Hyderabad, BHU, and Pondicherry University. The impact factor of this journal was high (3.05); thus, first choice of researchers is to publish their research work in high impact factor journals.

CONCLUSION

The study has attempted to analyse the science research publications of nine central universities of India in the last one decade (2011–2020). There were 53617 publications which received 796353 citations in total; thus, there was on an average 14.9 citations per article. RSC Advances was the most popular journal among the researchers. Researcher's preferred overseas publishers having good reputation for publishing research in science discipline more than 92% of total research work was published through these publishers. Almost all research works in science discipline were published in English At times, researchers in India lack proficiency in English language and so they fail to get published in the core journals of their field. Researchers need to be trained in writing quality research papers in English language.

This study has important implications for all stakeholders; so such bibliometric studies should be undertaken regularly. The study highlights research strength of nine central universities. The university authorities and funding bodies may initiate efforts to promote research areas and institutions based on their research output in terms of publications. The faculty members who excel in a research area may be deputed as mentors for young researchers working at other universities.

The study is germane to organizations and committees which conduct research audit of the universities in understanding quality of research work in international perspective. The study also highlights the journals in which the faculty members publish their research. If they are not able to publish in the top-ranking journals of their field, it implies that institutions need to make efforts to enhance the quality of their research work. Accordingly, financial support, infrastructure support should be provided for undertaking robust research. Such studies also help to identify performing institutions producing high quality research; and less performing institutions. Such studies help rationalize effective utilization of public funds in research. The performers should be suitably awarded to set exemplars for others to follow.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Širá E, Vavrek R, Kravcáková Vozárová I, Kotulic R. Knowledge economy indicators and their impact on the sustainable competitiveness of the EU countries. Sustainability. 2020;12(10):4172. doi: 10.3390/su12104172.
2. Deiaco E, Hughes A, McKelvey M. Universities as strategic actors in the knowledge economy. Camb J Econ. 2012;36(3):525-41. doi: 10.1093/cje/bes024.
3. Altbach PG. Advancing the national and global knowledge economy: the role of research universities in developing countries. Stud Higher Educ. 2013;38(3):316-30. doi: 10.1080/03075079.2013.773222.
4. Guskov AE, Kosyakov DV, Selivanova IV. Boosting research productivity in top Russian universities: the circumstances of breakthrough. Scientometrics. 2018;117(2):1053-80. doi: 10.1007/s11192-018-2890-8.
5. Aïssaoui R, Geringer MJ. International business research output and rankings of Asia-Pacific universities: A 40-year time-series analysis. Asia Pac J Manag. 2018;35(4):993-1023. doi: 10.1007/s10490-017-9536-x.
6. Cao Q. Contradiction between input and output of Chinese scientific research: a multidimensional analysis. Scientometrics. 2020;123(1):451-85. doi: 10.1007/s11192-020-03377-w.
7. Kivinen O, Hedman J, Kaipainen P. Productivity analysis of research in Natural Sciences, Technology and Clinical Medicine: an input–output model applied in comparison of Top 300 ranked universities of 4 north European and 4 East Asian countries. Scientometrics. 2013;94(2):683-99. doi: 10.1007/s11192-012-0808-4.
8. Jeon J, Kim SY. Is the gap widening among universities? On research output inequality and its measurement in the Korean higher education system. Qual Quant. 2018;52(2):589-606. doi: 10.1007/s11135-017-0652-y.
9. Aldieri L, Kotsemir M, Vinci CP. The impact of research collaboration on academic performance: an empirical analysis for some European countries. Socio Econ Plann Sci. 2018;62:13-30. doi: 10.1016/j.seps.2017.05.003.
10. Pastor JM, Serrano L, Zaera I. The research output of European higher education institutions. Scientometrics. 2015;102(3):1867-93. doi: 10.1007/s11192-014-1509-y.
11. M V, Kolle SR. Indian contribution in information science and library science research during 1991-2015: A bibliometric analysis. DESIDOC J Libr Inf Technol. 2017;37(6):387-95. doi: 10.14429/djlit.37.11005.
12. Satpathy SK, Sa MK. Research outputs of state government Universities of Odisha: A bibliometric study. Library Philosophy and Practice. 2015;1309.
13. Meera, Sahu SK. Research Output of University College of Medical Science, University of Delhi: A Bibliometric Study. COLLNET J Scientometr Inf Manag. 2014;8(2):401-18. doi: 10.1080/09737766.2014.954865.
14. Tahamtan I, Safipour Afshar AS, Ahamdzadeh K. Factors affecting number of citations: a comprehensive review of the literature. Scientometrics. 2016;107(3):1195-225. doi: 10.1007/s11192-016-1889-2.
15. Jamali HR, Nikzad M. Article title type and its relation with the number of downloads and citations. Scientometrics. 2011;88(2):653-61. doi: 10.1007/s11192-011-0412-z.
16. Letchford A, Moat HS, Preis T. The advantage of short paper titles. R Soc Open Sci. 2015;2(8):150266. doi: 10.1098/rsos.150266.
17. Subotic S, Mukherjee B. Short and amusing: the relationship between title characteristics, downloads, and citations in psychology articles. J Inf Sci. 2014;40(1):115-24. doi: 10.1177/0165551513511393.
18. Fox CW, Paine CET, Sauterey B. Citations increase with manuscript length, author number, and references cited in ecology journals. Ecol Evol. 2016;6(21):7717-26. doi: 10.1002/ece3.2505, PMID 30128123.
19. Adams J, Pendlebury D, Potter R, Szomszor M. Global research report multi-authorship and research analytics. Institute for Scientific Information; 2019. Available from: https://clarivate.com/webofsciencegroup/wp-content/uploads/sites/2/dlm_uploads/2019/12/WS419558643_ISI_Global_Research_Report_6_v9_RGB_SP pdf [cited 27/8/2021].
20. Castelvecchi D. Physics paper sets record with more than 5,000 authors. Nature News. 2015:17567. doi: 10.1038/nature.2015.17567.
21. Di Bitetti MS, Ferreras JA. Publish (in English) or perish: the effect on citation rate of using languages other than English in scientific publications (in English). Ambio. 2017;46(1):121-7. doi: 10.1007/s13280-016-0820-7, PMID 27686730.